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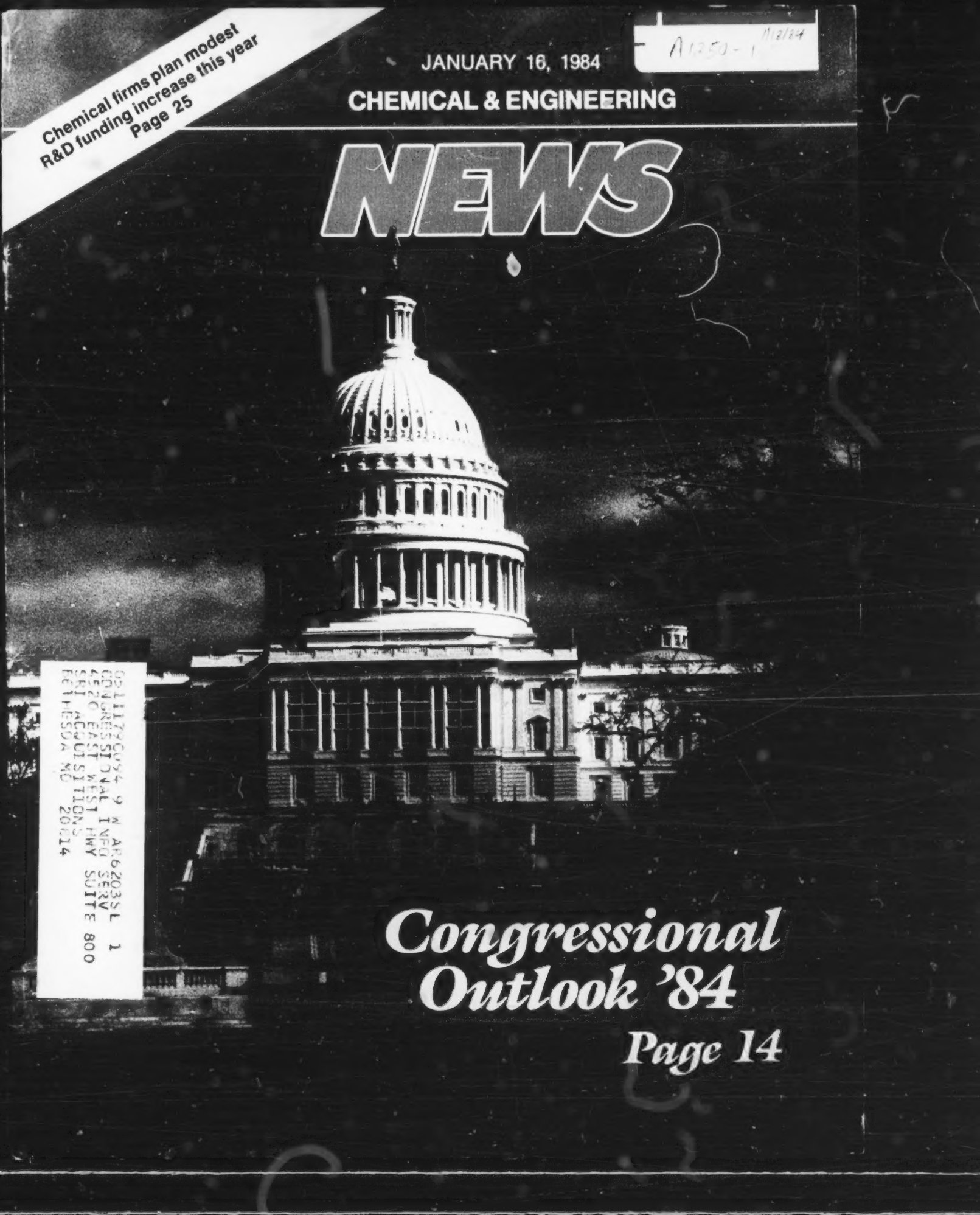
JANUARY 16, 1984

CHEMICAL & ENGINEERING

NEWS

Chemical firms plan modest R&D funding increase this year
Page 25



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Congressional Outlook '84

Page 14

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CHEMICAL & ENGINEERING NEWS

JANUARY 16, 1984

News of the Week

■ **Texaco's acquisition of Getty Oil would be largest buyout in U.S. history.** **Page 6**

■ **Reports of proton decay, from five research teams, are not considered definitive.** **Page 7**

■ **NASA asks for proposals defining orbiting space tug to reposition satellites.** **Page 7**

■ **Occidental Chemical agrees to clean up hazardous waste site at Niagara Falls, maintain safe drinking water supply.** **Page 8**

■ **OCAW contract with Gulf Oil contains slim wage hike, small increase in benefits.** **Page 8**

Business

U.S. chemical spending for R&D will increase in 1984 but only about 7%, barely above the inflation rate; many chemical company executives have change-of-control contracts. **Page 25**

International

Canadian government economic policies must be more flexible, responsive to the marketplace, chemical exec advises. **Page 28**

Science

Energy options to increase productivity could ameliorate buildup of carbon dioxide in the atmosphere; Saturn moon Titan may be covered by ocean of ethane. **Page 44**

Technology

B. F. Goodrich and the state of Illinois will test a high-sulfur coal boiler in $21.3 million demonstration unit. **Page 58**

Education

Number of people receiving doctorates in physical sciences and engineering is increasing after declines from the 1970s. **Page 58**

Books

"Experimenting with Truth" deplores separation between science and religion; sees need for a new concept of reality. **Page 63**

Letters 4

Concentrates
Business 20
Government 36
Science/Technology 40

The Departments
New Products 50
ACS Comment 70
Newscripts 86

News Focus

Second session of the 98th Congress must tackle budget, energy, environment, patents, in election year. **Page 14**

Chemical Firms' R&D Spending Will Rise Only Modestly in 1984

Planned boost in R&D funding by U.S. basic chemical firms of about 7% marks second consecutive year of small increases

David Webber, C&EN New York

Despite the strong recovery of earnings in the third quarter of 1983 and general expectation that fourth-quarter results, soon to be revealed, will look even healthier, chemical companies are planning only modest increases in their research and development budgets in 1984. A dozen large basic chemical firms surveyed by C&EN anticipate spending an average of just 7% more this year than last.

The relatively small boost not only provides a fairly narrow margin over expected higher costs—industrial R&D inflation will hit 5.3% this year, according to Battelle Columbus Laboratories—it also marks the second consecutive year in which R&D budgets will rise by a smaller percentage than they did the year before. Even aggressive research spenders like American Cyanamid, Dow Chemical, and Du Pont are expanding their budgets less than in 1983.

In consequence, although the technical professional unemployment rate as measured by the Bureau of Labor Statistics has fallen sharply since the summer, professional R&D staff size at chemical companies will grow only slightly—from 23,900 in 1983, according to the National Science Foundation, to some 24,300 this year. That level, however, still would be less than the 24,700 full-time R&D scientists and engineers (on an equivalent basis) working in the industrial chemical industry at the beginning of 1982.

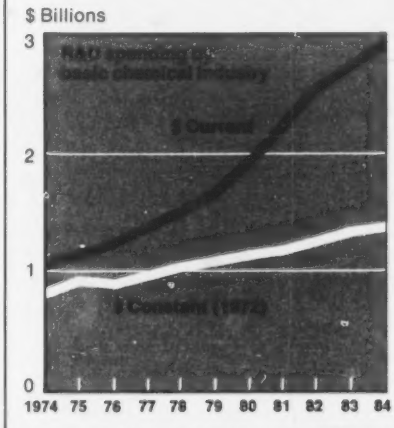
Companies will just not be spending enough money, on an inflation-adjusted basis, to hire many more R&D personnel. Based on Battelle Columbus Labs' cost of research index for the industry sector, constant-dollar (1972) spending for the companies surveyed by C&EN will rise to an estimated $1.32 billion in 1984 from $1.31 billion in 1983, an increase of just 1%.

The generally cautious approach to R&D spending shows even more clearly in the failure of more than half of the 12 companies whose budgets had been prepared by press time to plan budget increases higher than this year's projected research inflation rate. Only a handful of companies are responsible for the average boost. Indeed, if Du Pont figures (excluding Conoco), which lead the industry at a massive $945 million, were deleted from both 1983 and 1984 totals, overall industry R&D spending would be moving up at barely more than the inflation rate this year.

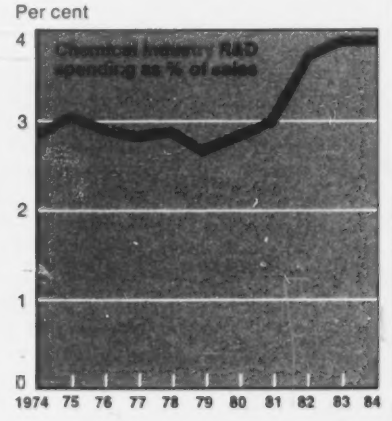
All this contrasts sharply with the heady growth in research budgets that characterized much of the half-decade before the 1983 decline. Double-digit increases, peaking at 16% in 1980, were the norm. And these big budget hikes exceeded the soaring inflation of the time as well. Between 1978 and 1982, constant-dollar spending on chemical R&D rose from $1.03 billion to $1.29 billion, a gain of more than 25%.

During the same period, chemical company R&D spending as a percentage of sales rose sharply, a seeming indication of growing chemical industry emphasis on research. The steady growth, from 2.7% in 1979 to 3.9% last year, is actually artificially high, because sales were dropping during much of the time span during which R&D spending was ascending. The most drastic gain can be seen in 1982, a recession year, when the share of

R&D budget increases will exceed inflation this year...



...but will remain unchanged as a per cent of sales



Sources: C&EN surveys, Battelle Columbus Laboratories

R&D spending gains will slow for second year in a row in 1984

$ Millions	Planned 1984	Actual 1983	Planned 1983	1982	1981	1980	1979	1978	Change from previous year 1984	Change from previous year 1983	R&D spending as % of sales 1983	R&D spending as % of sales 1982
Air Products	$ 42	$ 40	$ 40	$ 37	$ 32	$ 30	$ 24	$ 23	5%	8%	2.4%	2.3%
American Cyanamid	235	210	200	180	164	142	124	108	12	17	6.0	5.2
Celanese	na	na	100	100	104	94	92	83	na	na	na	3.3
Dow Chemical	508	485	480	455	404	314	269	232	5	7	4.5	4.3
Du Pont[a]	945	875	880	775	647	591	509	461	8	13	5.7	5.4
Ethyl	39	39	39	38	37	34	29	25	0	3	2.2	2.4
W. R. Grace	82	69	71	59	55	45	42	37	19	17	1.1	1.0
Hercules	66	66	68	67	61	53	47	40	0	−1	2.5	2.7
Lubrizol	38	36	36	36	33	28	23	21	6	0	4.4	4.5
Monsanto	na	na	284	264	221	204	161	136	na	na	na	4.2
Olin	55	50	48	45	39	31	26	25	10	11	2.6	2.5
PPG Industries	125	125	125	127	119	103	83	70	0	−2	3.4	3.9
Rohm & Haas	na	na	94	91	77	67	54	49	na	na	na	5.0
Stauffer Chemical[b]	66	63	64	57	49	44	35	32	5	11	4.7	3.6
Union Carbide	250	238	238	237	201	166	161	156	5	0	2.7	2.6
TOTAL	$2451[c]	$2296[c]	$2767	$2568	$2243	$1946	$1679	$1498			3.2%	3.7%
ANNUAL CHANGE	7%	9%	8%	14%	15%	16%	12%	12%				

a All figures exclude Conoco. b All figures restated for fiscal year ending Sept. 30. c For 12 reporting companies only. na = not available. **Note:** R&D expenditures from 1978 to present restated to include R&D spending as part of marketing function.

sales devoted to R&D budgets shot up to 3.8% from 3.0% in 1981.

This year, chemical research spending and sales are forecast to rise at about the same 7% pace. As a result, the ratio of research dollars to sales will remain at 3.9%.

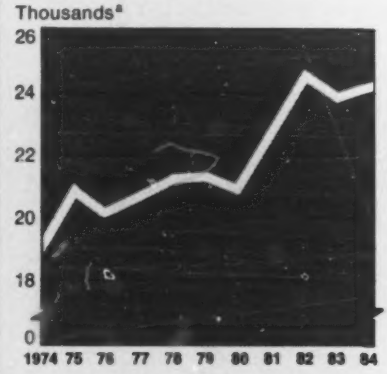
As last year, the company proposing the biggest R&D spending increase is W. R. Grace, with a 19% rise planned after 1983's 17% hike. But Grace, at $82 million, will remain just a middling spender. The major boosts will come from American Cyanamid, boosting spending 12% to $235 million, a $25 million increase from actual 1983 spending. Du Pont definitely is showing its teeth with an 8% increase in 1984 after a 13% hike last year. In current money, Du Pont R&D spending (exclusive of Conoco) will rise $70 million.

The only other chemical firms that have planned to increase their R&D budgets more than inflation are relatively small spenders: Olin, with a 10% increase to $55 million, and Lubrizol, after no increase in 1983, with a 6% boost to $38 million.

Dow Chemical, the second most prolific R&D spender, is raising its budget just 5% to $508 million this year, up from $485 million in 1983. An increase of the same proportion is planned by Union Carbide, whose 1984 R&D expenditures are expected to total some $250 million, up from $238 million last year. Three major firms—Celanese, Monsanto, and Rohm & Haas—did not have their 1984 R&D budgets prepared at press time.

At a point at which companies are nearly as cautious about commitments to expenditure as they were last year at this time, it is not surprising that it is those firms which traditionally have spent heavily on research which are leading the way. American Cyanamid, for instance, had an R&D spending-to-sales ratio of 6.0% last year. At Du Pont, spending on R&D accounted for 5.7% of sales. And among the other companies surveyed, it is mostly those which spend at least 4.0% of their sales dollars on research which are increasing R&D budgets by about the inflation rate. □

Professional R&D staffs begin to swell again...



a Full-time equivalent R&D scientists and engineers in basic chemical industry at beginning of year. **Sources:** National Science Foundation, C&EN surveys

...and technical professional unemployment falls sharply

a Unemployment rate for professional specialty employees, including engineers, mathematical and computer scientists, natural scientists, health diagnosing occupations, health assessment and treating occupations, teachers, lawyers, and judges. Not seasonally adjusted.
Source: Bureau of Labor Statistics

Increasing Energy Productivity Could Ease Greenhouse Effect

MIT/Stanford study tests effects of energy options on future buildup of atmospheric carbon dioxide using new, highly disaggregated model

On the basis of current understanding of the effect of carbon dioxide on climate and trends in global energy use, a significant CO_2 warming in the next century probably cannot be avoided. But early action will help to minimize later difficulties, and the most important and effective options relate to an increase in energy productivity worldwide.

That's the basic conclusion of a new study titled, "Global Energy Futures and CO_2-Induced Climate Change." Prepared for the National Science Foundation, the study was carried out by nuclear engineering professor David J. Rose of Massachusetts Institute of Technology, working with Marvin M. Miller of the MIT department of nuclear engineering and the energy laboratory and Carson Agnew of the engineering-economic systems department of Stanford University.

The new study follows closely a major study by the National Research Council and another by the Environmental Protection Agency (C&EN, Oct. 31, 1983, page 22). However, greenhouse-effect warming of Earth is a problem of such scientific, technological, and social complexity and dimension that no one study, or even series of studies, can exhaust the possible variations on the theme. The new study, which uses a different model than others for its calculations, thus adds to the continuing dialogue on the topic by taking a slightly different viewpoint and focusing on energy options relevant to ameliorating the buildup of CO_2 in the atmosphere in future years.

Whether a warming will occur isn't a central issue in the MIT/Stanford study. It accepts as given that increasing CO_2 will raise the mean global temperature and that such temperature rises due to CO_2,

MIT develops 11 scenarios that lead to different energy values in the year 2025

Scenario	Gross domestic product	Energy	Energy per GDP
Base case:[a] Availability of large quantities of inexpensive fossil fuels, particularly coal; an energy end-use efficiency increase of 1% per year in the industrial sector of Organization for Economic Cooperation & Development countries; no increases in end-use efficiency in OECD transportation and residential/commercial sectors or any sectors in non-OECD countries	1.00	1.00	1.00
Case A: Higher oil and gas prices; reduced biomass resources; higher nuclear costs	0.99	0.77	0.71
Case B: Reduced reserves and higher prices for coal	0.99	0.71	0.72
Case C: Combination of cases A and B (higher fossil fuel prices; smaller coal reserves; higher nuclear costs; reduced biomass resources)	0.97	0.59	0.61
Case D: Increased efficiencies; higher synfuel costs; optimistic view of development of photovoltaic technology; coal same as base case (large reserves at inexpensive prices)	1.00	0.78	0.78
Case E: Combination of all changes from previous cases except lower nuclear costs (as in base case)	0.98	0.65	0.66
Case F: Similar to case C but with solar costs greater than those of case D (about same as base case)	0.98	0.59	0.60
Case H: Case E but with no nuclear installations after year 2000	0.97	0.59	0.61
Case J: Case E but with higher unconventional oil price; cutoff in oil from Middle East in 2000; increased end-use energy efficiencies everywhere, in all sectors	0.98	0.52	0.53
Case K: Base case but with increased end-use efficiencies though less than cases A through J; higher nuclear costs; Middle East oil supply cutoff at 2000	0.98	0.71	0.72
Case L: Case E but with large decrease in unconventional resources; slight decrease in coal prices, increased end-use efficiencies	0.98	0.55	0.56
Case M: High end-use efficiencies; small coal reserves; high coal prices; small biomass resource; no unconventional oil; low solar prices	0.98	0.52	0.53

a Institute for Energy Analysis.

coupled with contributions from other greenhouse gases such as nitrogen oxides and chlorofluoromethanes, are much larger than anything in recorded history. Noting that well-recognized uncertainties exist in both timing and consequences of climate changes, the study finds that stringent measures to restrict use of fossil fuels now are both unjustified and infeasible.

However, there is potential for severe impacts, the possibility that such impacts will have a negative synergism with other environmental stresses occurring at the same time, and inertia in the energy supply and demand system. Hence, the study maintains, it makes sense to develop new strategies for reducing future fossil fuel carbon emissions, rather than relying solely on research to narrow uncertainties and/or ameliorative measures, such as building dikes and developing new strains of "greenhouse-resistant" crops.

Thus, the study concludes that the rate of increase of atmospheric CO_2 attributed to fossil fuel consumption can be reduced significantly through adoption of realistic energy strategies that the study terms relatively "CO_2-benign." It uses the term CO_2-benign to mean an atmospheric CO_2 increase from the present 340 ppm by volume to about 420 ppm by volume by the year 2050. Such an increase corresponds to a CO_2 doubling time of several centuries.

"While technical and other limits bound the range and composition of future global energy use," the study says, "the bounds appear to be fairly wide, with a spread of a factor of several in annual carbon emissions by the middle of the next century."

The most important and effective options, according to the study, relate to increasing energy productivity on a worldwide scale—an activity, it points out, that is beneficial quite apart from its impact on CO_2 and climate, and that can lead to a halving of global energy requirements per unit of production or service in less than 50 years. It will be impossible to develop global consensus for any one simple set of energy options, the study notes, because of different stages of industrialization, different available resources, different perceptions of climatological or economic winning or losing, and the like. However, based on recent attention to other international environmental problems such as acid rain, the study concludes that the time seems propitious for extending the global debate on the CO_2-climate issue.

Models play a central role in studies of the CO_2-climate issue. For example, the recent NRC study involved a model developed by economist William D. Nordhaus of Yale University along with Gary W. Yohe of Wesleyan University. That model went beyond earlier efforts that involved extrapolative techniques. Nordhaus and Yohe used what they call probabilistic scenario analysis to arrive at a projection that is not only a best guess but also a set of alternative trajectories and associated probabilities.

The MIT/Stanford resesarchers make note of the Nordhaus-Yohe model, as well as one by Gregory Hamm of Stanford's engineering-economic systems department. For their work, however, they chose a model developed by James Edmonds and John Reilly of the Institute for Energy Analysis, a component of Oak Ridge Associated Universities.

In comparing the models, the current study points out the importance of keeping in mind that the intent of the modelers is different. Nordhaus and Yohe, for instance, are interested mainly in determining the effect of current uncertainties in various energy-economic-carbon cycle parameters on the range of possible future paths for energy use and CO_2 emissions. Hamm's model, the study notes, seeks optimum futures in terms of an objective function that includes both discounted consumption and the effects of resource depletion, as well as a production function that accounts for CO_2 feedbacks to the economic sector. In both cases, a highly aggregated approach is used in an attempt to gain insight into the relative importance of uncertainties in the parameters that drive the energy-economic system.

The Edmonds and Reilly model, on the other hand, is intended as an analytic tool for exploring how alternative energy-CO_2 futures depend on a much more detailed specification of the energy-economic system. As such, the model is more difficult to use but gives the user more degrees of freedom to explore.

Thus, in comparison with the other models, the Edmonds and Reilly model is highly disaggregated. In principle, the MIT/Stanford study notes, it is useful for determining how future energy paths and CO_2 emissions depend on the relationships among the economy, energy supply and demand, and technological change. The study points out that the price the user pays for this flexibility is not an excessive amount of computation but the need to specify more than 60 categories of inputs, many of which can be further disaggregated by region, fuel type, and year.

Whereas the Nordhaus-Yohe and Hamm models contain no geographical disaggregation, for example, the Edmonds and Reilly model includes nine global regions, with end use in regions of the Organization for Economic Cooperation & Development divided into industrial, transport, and commercial/residential sectors. Similarly, whereas the other two models each contain one fossil and one nonfossil for energy supply types, the Edmonds and Reilly model has provision among types of energy supply for nine primary types, four secondary, and for solids, liquids, gases, and electricity.

Using an Institute for Energy Analysis scenario as a base case, the MIT/Stanford researchers developed 11 scenarios for analysis using the model. All assume increased end-use efficiencies, compared with the base case, and, except for one, have higher synfuel costs. They also explored the impact of both evolutionary and abrupt changes in energy supply conditions.

Several relatively CO_2-benign scenarios, the researchers note, are not low-energy in a Draconian sense. They would, however, require global awareness and collaboration, starting very soon. "While perhaps at the lower limit of possible realities," the researchers say, "these scenarios do not appear to us impossible." □